Speaker Bio: Dr. Ray Smith

Dr. Ray Smith completed a Biology degree from Asbury College in 1983 and Agronomy/Plant Breeding MS and PhD from the University of Georgia in 1987 and 1991, respectively. Dr. Smith has been the Forage Extension Specialist at the University of Kentucky since 2004 and was promoted to Extension Professor in 2010. He has an active extension and research program and is the lead faculty member for UK's successful Horse Pasture Evaluation Program.

Dr. Ray Smith is a native of Georgia and received his undergraduate degree from Asbury University in Kentucky in 1983. After teaching high school biology for two years he entered a graduate degree program in Agronomy and Plant Breeding at the University of Georgia. From 1991-2001, Ray held a research, teaching and extension position at the University of Manitoba, Canada with a focus on alfalfa and native grass breeding, seed production and forage management. He was the Forage Extension Specialist at Virginia Tech from 2001-2004 and is now Professor and Extension Specialist at the University of Kentucky. Ray is the current chair of the Continuing Committee for the International Grassland Congress and past President of the American Forage and Grassland Council. He has published 43 articles in refereed journals, presented 165 papers at professional conferences, written over 120 extension publications, and given over 670 extension presentations. Ray has been the advisor for 16 master's students, 4 PhD's, 5 Post-docs, and 26 senior research students. His current extension activities include working closely with county agents and producers; conducting applied forage research for Kentucky and the transition zone; helping organize state, regional, national, and international forage conferences; and writing applied agricultural publications. His current research projects include: evaluating forage varieties for grazing tolerance and yield, developing forage production systems, pasture evaluation methods, and developing computer and time-lapse photography teaching tools.

Applying Kentucky Dairy Forage Research for Beef Producers

University of Kentucky, Lexington, KY: *Ray Smith, Kenny Burdine, Kelly Mercier, John Allison, Gabriel Roberts, Rehanon Pampell, Nat Colten.* ***University of Tennessee, Knoxville, TN:*** *Gina Pighetti, David Butler, Gary Bates, Agustin Rius, Peter Krawczel, Elizabeth Eckelkamp, Hannah Bailey, Victoria Couture, Karen Leu, Samantha Beal.* ***Virginia Tech, S. Piedmont Station, Blackstone, VA****: Katie Payne*

In 2015 the University of Kentucky and the University of Tennessee was awarded a USDA-NIFA grant that we refer to as the Southeast Organic Dairy Project. The goal of this project was to develop science-based recommendations to efficiently manage forages, herd health, and overall farm productivity on organic dairies in the Southeastern US. There are only about 40 organic dairies in Kentucky, but the over 35,000 beef cattle operations in the state will also benefit from this research. We are learning the best forage combinations for Kentucky and Tennessee soils and growing conditions. We are learning how to maximize forage yield, forage quality, and soil health and how efficient forage production and animal management can add to the bottom line. Although this project is limited to an organic management system, the principles of growing better forages for cattle are universal whether you farm organically or use commercial fertilizers and pesticides.

Here is the official objective of the project: Large-scale evaluation of forage mixtures on cow health, fertility, productivity, and efficiency on organic dairy operations. The best forage combinations will be tested on farm and cows followed closely to monitor body condition, production, activity, reproduction, lameness, and mastitis. To do this, we are working with five organic dairy producers in Kentucky and Tennessee and conducting on-farm sampling of multiple different areas of management.

Preliminary Forage Quality Results

As I mentioned, a number of the findings for this project relate to beef cattle producers, especially the forage quality results. Forage samples were all sampled within one week before grazing, dried, ground, and analyzed for nutritive quality. The results shown below are from the first year of the project. The four forage mixtures analyzed included multiple warm and cool season species (Table 1) and were analyzed for quality on a season long basis. For crude protein (CP) (Table 2), values ranged from 16.5-20.1% in the spring, 16.1-18.9% in summer, and 10.8-24.8 in the fall. For acid detergent fiber (ADF) (Table 3), values ranged from 29.3-31.6% in the spring, 30.4-35.2% in the summer, and 24.3-32.8% in the fall. Lastly, for neutral detergent fiber (NDF) (Table 4), values ranged from 44.1-47.9% in spring, 46.9-56.9% in summer, and 39.3-59.2% in fall. To optimize the amount of nutrients obtained on pasture, producers should strive to achieve legume based forage mixtures with 20-23%CP, 26-30%ADF, and 38-42%NDF (Pennsylvania State University Extension, L.D. Muller). Mixtures deviated approximately +/- 10% from suggested values. However, on average, forage mixtures were very close to recommended averages, suggesting these forage mixtures may be useful for southeast organic dairy grazing systems and for the almost 80,000 beef cattle farms in KY and TN.

These results show that very high quality forages can be grown for pastures in Kentucky and Tennessee. Even the forage mixtures that contained warm season annual grasses maintained forage quality. The main criteria is to select superior varieties and to manage in a rotational grazing system.

Table 1. Forage combinations in test plots.	
Plot	**Species**
Red Clover Mix	Annual Ryegrass, Red Clover, Crabgrass, Annual Lespedeza
Crimson Clover Mix	Annual Ryegrass, Crimson Clover, Sudex, Cowpea
Alfalfa Mix	Alfalfa, Red Clover, Orchard Grass, Tall Fescue
Cowpea Mix	Turnip, Rape, Oats, Annual Ryegrass, Sudex, Cowpea

Table 2. Crude protein (CP) concentrations of forage mixtures on a DM basis

Plot	SPRING	SUMMER	FALL
Red Clover Mix	16.74	18.53	24.67
Crimson Clover Mix	16.47	15.89	-----
Alfalfa Mix	20.08	18.91	20.4
Cowpea Mix	16.48	16.08	10.78

Table 3. Acid Detergent Fiber (ADF) concentrations of forage mixtures on a DM basis

Plot	SPRING	SUMMER	FALL
Red Clover	31.63	35.16	27.68
Crimson Clover	30.48	35.31	-----
Alfalfa	29.25	30.41	24.26
Cowpea	30.38	35.12	32.84

Table 4. Neutral Detergent Fiber (NDF) concentrations of forage mixtures on a DM basis

Plot	SPRING	SUMMER	FALL
Red Clover	47.92	53.09	39.26
Crimson Clover	47.05	56.85	-----
Alfalfa	44.09	46.86	43.55
Cowpea	47.66	54.33	59.17

Forage Economics

A major component of this project is to determine the estimated costs of production for a farm forage system. John Allison recently completed his Master's degree with Dr. Kenny Burdine. For his master's research he developed an economic model to determine which forage system was the most profitable. Although the complete results of John's model will not be published for several months, he showed clearly that the perennial forage system was the most economical. The forage yield and quality of the perennial system was similar to the winter and summer annual systems, but it provided tremendous savings since the costs of planting can be prorated over the 4-5 year estimated stand life.

John also developed an excel-based decision management tool that allows precise calculations for the Estimated Costs of Production of different forage systems. In John's own words "this decision tool has been created to assist producers with calculating and analyzing the costs associated with complex forage mixtures for organic dairy systems." As with the forage quality analysis above,

the outputs from this decision aid are not only applicable to dairy systems, but also to beef cattle operations. Below is just one example of the variables that can be inputed into the decision aid and the economic numbers that are generated. Producers simply progress through a series of input tables that will be able to determine the exact cost of production for the forage system they are planning. This Decision Aid will be available online by early 2020.

Cool Season Mixture for Pasture (Mix C) - Estimated Total Annual Costs Per Acre						
Species:	Alfalfa, Red Clover, Orchardgrass, Tall Fescue			Yield (DM Tons/Acre):		4
		Quantity	Unit	Price		Total
Variable Establishment Costs (prorated for stand life)						
Lime & Application		2	tons	$20.00		$10.00
Alfalfa Seed		10	lbs.	$4.50		$11.25
Red Clover Seed		5	lbs.	$3.00		$3.75
Orchardgrass Seed		5	lbs.	$3.50		$4.38
Tall Fescue Seed		8	lbs.	$3.50		$7.00
Custom Hire (Relative to Tillage & Seeding)		1	acre	$72.50		$18.13
Total Variable Establishment Costs Per Acre						**$54.50**
Variable Costs Per Acre						
Dairy Manure		2	tons	$15.00		$30.00
Other Labor		0	hrs.	$11.00		$0.00
Custome Hire		1	acre	$50.74		$50.74
Machinery Rental		1	acre	$0.00		$0.00
Machinery Fuel and Lube		1	acre	$0.00		$0.00
Machinery Repairs & Maintenance		1	acre	$0.00		$0.00
Cash Rent Equivalent		1	acre	$45.00		$45.00
Other Variable Costs		1	acre	$0.00		$0.00
Operating Interest	6%	$180.24	dollars	Months	6	$5.41
Total Variable Costs Per Acre						**$131.15**
Fixed Costs Per Acre						
Operator Labor		0	hrs.	$18.00		$0.00
Machinery Depreciation and Overhead		1	acre	$0.00		$0.00
Other Fixed Costs		1	acre	$0.00		$0.00
Total Fixed Costs Per Acre						**$0.00**
Total Variable & Fixed Costs Per Acre						**$185.65**
Average Cost Per Ton of Dry Matter						**$46.41**

Extension Publications

A series of extension publications are being developed from this project. One of the first publications was developed by professors and graduate students at the University of Tennessee entitled "Forage Mixtures for Dairy Grazing." As mentioned in the above sections, the information in this publication is informative to dairy producers, but 90% of the information is also directly applicable for beef cattle producers in KY and TN. We are including this complete publication both as an example of extension deliverables from the project, but more importantly for the information contained on Forage Mixtures. Please take the time to read the publication and look on the UK Forage Website for additional extension publications coming out of this project in the next year.

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FORAGE MIXTURES FOR DAIRY GRAZING

Victoria Couture and Hannah Bailey, Graduate Research Assistants, Department of Animal Science
Elizabeth Eckelkamp, Assistant Professor, Department of Animal Science
David Butler, Associate Professor, Department of Plant Sciences
Peter Krawczel, Associate Professor, Department of Animal Science
Gary Bates, Professor, Department of Plant Sciences

One of the biggest challenges facing a dairy operation is the difficulty of providing high-quality feed to a lactating cow. Often dairy producers will feed a total mixed ration, or TMR, consisting of corn silage, hay or haylage, and various grains. Dairy producers may not consider incorporating grazing into their feeding programs, assuming it takes too much land and time, or fearing that milk production will decrease due to a lower quality diet. With the right management and the proper forage species, as little as 5-10 acres can be grazed, replacing 20-30 percent of the TMR with no drop in milk production.

THINK OF YOUR FIELD AS A FEED TROUGH

When many producers think of grazing pasture, they may picture cattle staying all day on the pasture, part of the time grazing and part of the time laying. However, supplemental grazing can be accomplished without remaining all day in a pasture. Planting a small acreage of high-quality forage that the animals can access one or two times a day to graze can provide a high-quality supplement or replacement for a portion of the TMR. After they have finished grazing and begin to lie down, usually 30-45 minutes, they should be moved out of the pasture to prevent damage to the forages.

This concept is one that many dairy producers are familiar with, but they may be hesitant to implement due to lack of time, land or diet quality concerns. However, grazing a herd or group of 50 to 150 dairy cows on high quality forages can reduce feed cost while maintaining milk production. By relying more on pasture, the costs associated with producing stored feeds are reduced, which makes grazing a cost effective option for some producers.

GETTING STARTED

Before planting, a few questions should be answered. How much land are you setting aside for grazing? Pastures should be separated into small paddocks for best usage, but as little as 5-10 acres can be sufficient, depending on herd size and forage yield. The acreage selected should be located relatively close to the milking parlor or loafing area in which the cattle normally are kept. It is preferable to minimize the distance cattle need to walk to pasture, especially since they may only be in these pastures for 30-45 minutes at a time, one or two times a day.

POTENTIAL FORAGE MIXTURE

There are several forage species that can provide high-quality forage for this strategy. Trying various species with which you are familiar in your operation can enhance your mixture and your success. The goal with any species mixture is to include both grasses and legumes, which provide high yield, high quality, and a reduced need for nitrogen fertilization due to nitrogen fixation by the legume. The following species mixtures have been successfully utilized on dairy farms in Tennessee.

Orchardgrass, tall fescue, red clover, white clover, and alfalfa

This is a perennial mix with reliable production over a long grazing season. This mixture can be planted either conventionally or no-till. If planting no-till, be sure to use a herbicide such as glyphosate to kill all existing vegetation. The planting date and seeding depth recommendations are similar for all species, simplifying planting. This mixture can be planted in the fall, with grazing beginning the following spring. Under good conditions, this cool-season mix should be productive into midsummer and again in the fall.

The high legume component in this mixture results in no need for nitrogen fertilization. Phosphate, potash and lime should be applied based on soil test results. Apply 2 pounds of boron per acre each year to meet the alfalfa needs.

Species mixture	Seeding rate (lb/acre)	Comments
Orchardgrass	3-5	Seeding depth: 1/4 inch Seeding date: Aug 15–Oct 1 *Be sure to use either endophyte- free or a novel endophyte infected tall fescue variety. Do not use KY 31 endophyte infected tall fescue. For legumes, be sure to use pre-inoculated seed or alfalfa-true legume inoculant
Tall fescue	7-10*	
Red clover	4	
White clover	2	
Alfalfa	10	

Sorghum x sudangrass hybrid/ cowpea; wheat/crimson clover

This is a high-yielding combination that uses both warm- and cool-season annuals to provide a long grazing season. Since it uses two annual mixtures, two separate seedings are required. These can be seeded either in a conventional or no-till practice. Using no-till will allow for more timely establishment and a firmer seedbed. To prepare for no-till planting, apply glyphosate as recommended by the label to kill all existing plants. The sorghum x sudangrass hybrid and cowpeas should be planted in late spring, and will be ready to graze in 30-45 days. This mixture can be grazed until early September, then killed in preparation for planting wheat and crimson clover. Wheat and crimson clover can be grazed until early May, then killed and rotated back to sorghum x sudangrass hybrid and cowpea.

Since there are two plantings each year, there is more risk of weather issues such as drought or cool temperatures limiting the early season forage availability with this program. Establishment costs also tend to be higher with this mixture.

Both the cool- and warm-season mixtures contain a legume, so nitrogen fertilization may not be needed. Evaluate the legume stand after establishment to determine if nitrogen fertilization is needed. Phosphate, potash and lime should be applied based on soil test results.

Species mixture	Seeding rate (lb/acre)	Depth (in.)	Seeding date	
			Spring	Fall
Sorghum x sudangrass	30	½-1	Apr 20-June 15	-
Cowpea	50			
Wheat	100-150	¼-½	-	Aug 15-Nov 1
Crimson clover	20-25			

Annual ryegrass, crabgrass and red clover

This mixture utilizes two cool-season species (annual ryegrass and red clover) and one warm-season species (crabgrass). These species should provide forage production for a large portion of the year without having to spray and re-establish between seasons. All of these species are relatively aggressive as seedlings, allowing for seeding with limited soil disturbance. In fact, if stubble height is minimized, all of these species can be successfully established by broadcasting on the soil surface. The annual ryegrass and red clover should be planted in the fall, providing grazing during winter and spring. The field should be grazed down or mowed in late spring and the crabgrass can be over-seeded either by drilling or broadcasting. Pulling a harrow or lightly disking can improve seed to soil contact. Once this rotation is established, each species can be planted by broadcasting and harrowing a field during the appropriate seeding window.

Annual ryegrass and crabgrass are both annual species, while red clover is typically biennial (lives for two years). It is possible to manage this mixture so that seed is only added every two or three years. All of these species are good seed producers, so light grazing during the spring and late summer will allow these species to reseed.

Red clover has been shown to provide significant amounts of nitrogen to a grass mixture, so nitrogen fertilization may not be needed. If the red clover portion of the mixture is reduced in some years, it may be beneficial to apply nitrogen to the annual ryegrass in spring or the crabgrass during summer. Phosphate, potash and lime should be applied based on soil test results.

Species mixture	Seeding rate (lb/acre)	Depth (in.)	Seeding date	
			Spring	Fall
Annual ryegrass	20-30	¼-½	-	Aug 15-Oct 15
Red clover	8		Feb 15-Feb 28	Aug 15-Oct 15
Crabgrass	3-5 PLS		May 1-July 1	-

GRAZING MANAGEMENT

The goal of this type of system is to allow the cattle to select a high-quality diet, thereby maintaining milk production. Since the most nutritive portion of the plants will be the leaves and upper stem, do not force the milking herd to utilize all of the standing forage. Let these animals graze the top portion of the canopy, then move them to a new paddock for the next grazing. Allow dry cows or heifers to graze the remaining forage in the paddock.

The sorghum x sudangrass/cowpea mixture should be grazed when it reaches approximately 25-30 inches tall, while the other mixtures should be grazed when they reach 10-12 inches tall. A good rule of thumb is to let the milking herd graze the top 30-50 percent of the forage, leaving the next 25-30 percent for dry cows, and leaving 25-30 percent as stubble for adequate regrowth.

FINAL THOUGHTS

As in any production system, there are pros and cons with each of these forage mixtures. While each can support milk production while reducing feed costs, diversifying forage production will help provide for a more reliable grazing system year-round. Consider planting separate acreage to two of these to ensure grazing in between plantings and throughout the seasons.

Professor Joe Burns

Funding for this publication was provided by the Joe Burns Memorial Endowment. Professor Joe Burns spent his career educating forage producers in Tennessee and across the Southeast. He was a nationally renowned forage specialist with University of Tennessee Extension and served in that role for 37 years before retiring in 1992. During his career, he was honored as the Tennessee Man of the Year in agriculture by Progressive Farmer magazine and was awarded both the Merit Award and the Distinguished Grasslander Award from the American Forage and Grassland Council. Burns was well-known not only for his knowledge but also for his kind and encouraging attitude. He was a role model and mentor for many faculty at UT and producers across the state.

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